Structural Design for Beijing Grand MOMA

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Summary

Beijing Grand MOMA sited adjacent to the center of Beijing, has 9 towers, one kindergarten and one cinema. The 12 to 21 storied towers with frame-core wall structure are divided into 7 structural units, and are linked by 8 bridges at the top. The bridges span from 30m to 55m. This paper introduces the design of basement and foundation, bridges and seismic design of towers.

Keywords: tall building; linked structure; isolation; Friction Pendulum; performance based design.

1. Introduction

Fig. 1: Beijing grand MOMA

Beijing Grand MOMA, 220,000 square meters, contains 2 storied basement, 9 towers from 12 to 21 stories, one kindergarten and one cinema. The whole basement is connected without permanent gap. The towers are divided into 7 structural units from the ground floor, and are linked by 8 bridges at the top. The bridges span from 30m to 55m.

Steven Holl Architects is in charge of architectural design. Guy Nordenson and Associates (GNA) is in charge of SD, GNA and CABR cooperated in DD, CABR and Beijing Capital Design Institute complete CD work.

2. Basement and foundation

Different foundation scheme is used for different portions to deal with the differential settlement. Pile and raft is used for towers, raft is used for podium, and anti-floating pile and raft is used for 210mx83m pure basement. Post-poured strips are arranged every 40m to 50m and around the

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towers. The towers are constructed first, and the post-poured strips around the towers are kept open until the structure of towers is completed. Other post-poured strips are kept open for at lease 2 months after the concrete is poured to solve the problem of concrete shrinkage.

3. Design of linked structure

Tension Friction Pendulum bearings from Earthquake Protection Systems Inc. are adopted in this project for their small size and tension capacity.

Fig. 2: Tension Friction Pendulum bearing

Fig. 3: Analysis model of linked structure

Displacement of bearings is got from the nonlinear time history analysis result under maximum considered earthquake. The displacement capacity of bearings is set to be 500mm. Vertical earthquake is also considered to determine the vertical load capacity of bearings.

4. Seismic design of towers

In addition to the exterior concrete moment frames, steel and steel reinforced concrete bracing diagonals insure required stiffness for the upper, cantilevered portions of the buildings. A cruciform plan of shear walls is included to increase global stiffness for overturning moments as well as resisting large earthquake inertial forces.

There are large setbacks on top of podium. Extra diagonals are added to make the stiffness continuous near the setback, and the corner columns at that portion are designed to be steel reinforced concrete columns to delay their failure

Concept of performance based design is used in this project. Members in weak position are designed to be stronger than other members. To achieve the performance target, push over analysis is applied.

5. Conclusions

1）Post-poured strip and different foundation scheme can solve the problem of concrete shrinkage and differential settlement.

2）Using of isolators improves the performance of a linked structure. The interaction of bridges and towers can be greatly reduced.

3）Bracing in façade concrete frame can be a good way to control the stiffness and the load distribution between different portions of the structure.

4）Concept of performance based seismic design is helpful in design of a complicate structure. By strengthening the key members according to the structural analysis under maximum considered earthquake, the performance of structure can be greatly improved with a moderate expense.

The construction of the structure have been finished at the beginning of 2008, inner decoration are still undergoing.